completely, the entire cartridge being consumed. Tests made at San Francisco show that the cartridges will burn for about three hours.

One great advantage of the device is that the heat can be applied where most needed, namely, as close to the fruit as possible, and there is no heat wasted in warming up all out-of-doors. The method is cleaner than any ordinary uncovered system using crude oil, as the objectionable soot particles are in large measure deposited on the inner side of the cover. If the outer surface becomes black no harm is done, as, other things being equal, a black surface radiates heat better than other surfaces.

The covers remain in place until danger of fros is passed. They can then be stacked so as to occupy but little space.

FIGHTING FROST.

By Mr. J. E. ADAMSON, of Pomona, Cal.

The possibility of saving fruit crops from frost damage is simply a question of energy intelligently applied.

In our experiments in this work it was soon realized that success depends largely on two things, viz, early lighting to blanket the earth and conserve the latent heat, and the subdivision of the fuel into many fires to offset the fact that the horizontal radiation from fires in the open is very slight.

In regard to conservation, we have found that on nights of low relative humidity the earth will begin to crust over at about 28° F., therefore it was decided to assume 30° F. as a desirable point to begin firing. The wisdom of this has been fully proven this past season by the ease with which temperatures were maintained, as compared with other seasons when we waited longer before lighting. My own practice was to get out at 30° F. and light fires to windward of about each 15 rows of trees, and then watch for any tendency to drop to lower temperatures under the blanket of smoke, lighting additional fires to prevent any drop below 28° F.

My grove lies in a very difficult position for easy work. Being sheltered by a low range of hills, we are sometimes in a dead calm while districts not far distant are under the influence of a strong desert wind. Then, as the rows of trees are at a considerable angle to the prevailing drift on frosty nights, I find it necessary to light the north and east sides to secure a good covering of smoke.

Comparing the fall of temperature under the smudge with that in the open to windward, it would seem that the smudge delayed the fall at least two hours, after which it will be found necessary to light more fires to hold the temperature. I had no trouble holding 30° in the fire zone, while it fell to 22° at a point 200 feet to windward, with 900 fires to 1,000 trees.

The fact that it was necessary to go so far to windward to find the minimum temperature accounts for the fact that so many investigations seem to show only 2° or 3° gain of temperature in the fire zone. This is easily accounted for by the increase in air circulation, caused by the heat rising from the fires, producing a gentle but effective air mixture.

The question of subdivision of fires has been provided for by using 1 gallon of oil for seven to eight hours burning. The value of the subdivision will be seen from a simple comparison. If we have 100 trees planted 20 feet apart we would have a square 200 feet on each side. Now, if 100 gallons of oil were burned in one fire there would be intense heat close to the fire, but as the radiation is very slight horizontally, there would be found very little effect beyond 30 feet, while if the oil were divided into 100 fires (one to each tree) there would be no great heat at any one point, but it would be distributed over the whole tract.

One desirable point in firing devices is a regular rate of burning from start to finish, a condition not met in any burner which has come to the notice of the writer. To get the desired result it is easily seen that the oil must be at a uniform distance from the rim of the container.

Working along this line, we conceived the idea of using a paper container and, as finally put into practice in the season of 1909–10, a heavy paper bag, known to the grocery trade as "No. 4 sugar," was used. Filled with crude oil the bag was fired by dropping in a small quantity of burning distillate. The bag and contents burned down very regular and gave excellent results.

Several thousand were used that season, the cost being $3.50 per 1,000; but their use was discontinued for the reason that it was found difficult to get a bag without a leak in the seam where the bag is folded.

The work of the past season was carried on with different types of metal pots, using slop distillate. The frost periods this season were not severe or protracted, but just enough came to prove the value of the work.

I have lemon trees full of fruit that went through the frost as small fruit, while groves in the immediate neighborhood have no small fruit.

Summing up the results of our work, I would say that the most important part is not the saving of the fruit or trees this season, but the feeling of satisfaction coming from the fact that we realize the fight can be carried out along definite lines. The principles involved are three, viz, blanketing to minimize radiation; heating to offset radiation; and air mixing, caused by the increased circulation due to the heated air rising.